Due to a constant demand for non-renewable energy, the research on renewable energy has undergone a rapid growth as an alternative energy source. It also protects from environmental pollution such as air, water and soil. As a renewable energy source, solar energy source falls on the terrestrial in the world. This energy is completely harvested by photovoltaic solar cell which converts light into electricity. There are different generations of photovoltaic solar cell such as first generation pn-junction solar cell (crystalline Si), second generation pn-junction solar cells (amorphous Si, ZnO, Cu_2O, CdS, CuInSe_2, CuInGaSe_2 and InGaP) and third generation dye sensitized solar cell (TiO_2, ZnO, SnO_2 and Nb_2O_3). Among the aforementioned solar cells, the third generation dye sensitized solar cell is significantly attractive due to easy fabrication, cost effectiveness, abound material and low processing temperature compared to first and second generation solar cells.

In dye sensitized solar cells (DSSCs), the photoanode materials play a pivotal role in enhancing the efficiency of the solar cell. ZnO has some superior properties including high electron mobility, direct wide gap, and large exciton binding energy. It is easy to synthesize diverse morphologies by employing chemical deposition methods. The individual ZnO morphology deposited on FTO substrate as a photoanode has some disadvantage such as recombination between back transfer electron and the oxidized dye or electrolyte species and the recombination among the collected electrons and the oxidized electrolyte species. These types of recombination could able avoided by synthesising the appropriate morphologies as building blocks.

Based on the above concepts, the present work emphasizes on enhancing the efficiency of DSSC by stacking diverse morphologies on FTO substrate as low
dimensional thin film form. The present doctoral dissertation is classified into the nine chapters and is organized as follows.

Chapter-I encompasses the introduction of photovoltaic, types of solar cell, dye sensitized solar cell, its working principles and deposition techniques.

Chapter-II elucidates the materials introduction, review of literature survey, scope of the work, materials used for preparations, experimental procedure for thin film, photoanode, counter electrode preparations and dye sensitized solar cell fabrication, and the material characterization techniques are presented.

Chapter-III explains and optimizes the effect of deposition potentials and bath temperatures on electrochemically deposited ZnO thin films. The SEM images of films show one or two dimensional nanostructures. The one dimensional nanostructure deposited –1.3 V at 70 °C shows higher crystalline nature, crystal quality, film thickness, dye loading and short circuit current density.

Chapter-IV elaborately deals with the effect of HMTA on ZnO with metallic Zn thin film. The thin film deposited using 9 mM HMTA has good crystallinity with highly (002) plane growth direction. It shows nanoneedles like morphology and has wurtzite structure with less atomic defects. The DSSC based on nanoneedles exhibits an efficiency of 1.02 % with less charge transfer recombination.

The effect of HMTA on morphologies of ZnO thin films electrochemically grown on ZnO seeded FTO substrate is investigated in chapter-V. The ZnO film deposited using 9 mM HMTA displays nanorods morphology growth with (002) plane direction, higher crystallinity, less atomic defects and higher dye loading. The efficiency of DSSC is found to be 3.75 % with higher charge transfer recombination resistance.

Chapter-VI deals with hydrothermal synthesis of ZnO NWAs on ZnO-TiO₂ seeded FTO substrate. ZnO NWAs are hexagonal morphologies with vertical growth
along the c-axis orientation, which has high dye loading and high crystallinity with less atomic defects. The DSSCs based on ZnO-TiO$_2$ and NWAs exhibit efficiencies of 0.56 and 0.84 %, respectively.

**Chapter-VII** focuses on the effect of solution concentrations and growth times on the hydrothermally grown ZnO thin films on ZnO-TiO$_2$ seeded FTO substrate. The films synthesized 3 and 5 h are NWAs and NNAs respectively. The NNAs possess a high crystalline nature, crystal quality, reflectance and dye loading, charge transfer recombination resistance compared to NWAs. The efficiency of DSSCs based on NWAs and NNAs is found to be 0.91 and 1.47 % respectively.

**Chapter-VIII** addresses the light scattering ability of microsphere and hierarchical on ZnO-TiO$_2$ seeded FTO substrate deposited by applying two steps electrochemical and hydrothermal techniques. The hierarchical structure has a higher light scattering ability with more dye loading. The DSSC based on hierarchical structure has a higher efficiency of 4.64 % with less charge recombination.

**Chapter-IX** comprehensively summarizes the entire thesis results.